Evolution of Microprocessors

Historical Background of Intel Microprocessors

- **Intel 4004**

Year of introduction 1971

- 4-bit microprocessor
- 4 KB main memory
- 45 instructions
- PMOS technology
- was first programmable device which was used in calculators

Historical Background of Intel Microprocessors

- **Intel 8008**

Year of introduction 1972

- 8-bit version of 4004
- 16 KB main memory
- 48 instructions
- PMOS technology
- Slow

Historical Background of Intel Microprocessors

- **Intel 8080**

  Year of introduction 1973

  - 8-bit microprocessor
  - 64 KB main memory
  - 2 microseconds clock cycle time
  - 500,000 instructions/sec
  - 10X faster than 8008
  - NMOS technology
  - Drawback was that it needed three power supplies.
  - Small computers (Microcomputers) were designed in mid 1970's using 8080 as CPU.

Historical Background of Intel Microprocessors

- **Intel 8085**
  - Year of introduction 1975
  - 8-bit microprocessor-upgraded version of 8080
  - 64 KB main memory
  - 1.3 microseconds clock cycle time
  - 246 instructions
  - Intel sold 100 million copies of this 8-bit microprocessor
  - uses only one +5v power supply.

Historical Background of Intel Microprocessors

- **Intel 8086/8088**

  Year of introduction 1978 for 8086 and 1979 for 8088

  - 16-bit microprocessors
  - Data bus width of 8086 is 16 bit and 8 bit for 8088
  - 1 MB main memory
  - 400 nanoseconds clock cycle time
  - 6 byte instruction cache for 8086 and 4 byte for 8088
  - Other improvements included more registers and additional instructions
  - In 1981 IBM decided to use 8088 in its personal computer

Historical Background of Intel Microprocessors

- **Intel 80186**

Year of introduction 1982

- 16-bit microprocessor-upgraded version of 8086
- 1 MB main memory
- Contained special hardware like programmable counters, interrupt controller etc.
- Never used in the PC
- But was ideal for systems that required a minimum of hardware

Historical Background of Intel Microprocessors

- **Intel 80286**

Year of introduction 1983

- 16-bit high performance microprocessor with memory management & protection
- 16 MB main memory
- Few additional instructions to handle extra 15 MB
- Instruction execution time is as little as 250 ns
- Concentrates on the features needed to implement MULTITASKING

Historical Background of Intel Microprocessors

- **Intel 80386**

Year of introduction 1986

- Intel's first practical 32-bit microprocessor
- 4 GB main memory
- Improvements include page handling in virtual environment
- Includes hardware circuitry for memory management and memory assignment
- Memory paging and enhanced I/O permissions

Historical Background of Intel Microprocessors

- **Intel 80486**

Year of introduction 1989

- 32-bit high performance microprocessor
- 4 GB main memory
- Incorporates 80387-like floating point coprocessor and
- 8 K byte cache on one package
- About half of the instructions executed in 1 clock instead of 2 on the 80386

Historical Background of Intel Microprocessors

- **Pentium**

Year of introduction 1993

- 32-bit microprocessor, 64-bit data bus and 32-bit address bus
- 4 GB main memory
- Double clocked 120 and 133MHz versions
- Fastest version is the 233MHz, Dual integer processor
- 16 KB L1 cache (split instruction and data: 8 KB each)

Historical Background of Intel Microprocessors

- **Pentium Pro**

Year of introduction 1995

- 32-bit microprocessor, formerly code-named P6
- 64 GB main memory, 64-bit data bus and 36-bit address bus
- 16 KB L1 cache (split instruction/data: 8 KB each), 256 KB L2 cache
- Uses three execution engines
- Intel launched this processor for the server market

Historical Background of Intel Microprocessors

- **Pentium II**

Year of introduction 1997

- 32-bit microprocessor, 64-bit data bus and 36-bit address bus, MMX
- 64 GB main memory
- 32 KB split instruction/data L1 caches (16 KB each)
- Module integrated 512KB L2 cache (133MHz)
- A version of P2 called Xeon; specifically designed for high-end applications

Historical Background of Intel Microprocessors

- **Pentium III**

Year of introduction 1999

- 32-bit microprocessor, 64-bit data bus and 36-bit address bus
- 64 GB main memory
- Dual Independent Bus (simultaneous L2 and system memory access)
- On-chip 256 KB L2 cache
- P3 was available in clock frequencies of up to 1 GHz

Historical Background of Intel Microprocessors

- **Pentium IV**

Year of introduction 2002

- 32-bit microprocessor, 64-bit data bus and 36-bit address bus
- 64 GB main memory
- 1.4 to 1.9 GHz and the latest at 3.20 GHz and 3.46GHz (Hyper-Threading)
- 1MB/512KB/256KB L2 cache
- Specialized for streaming video, game and DVD applications

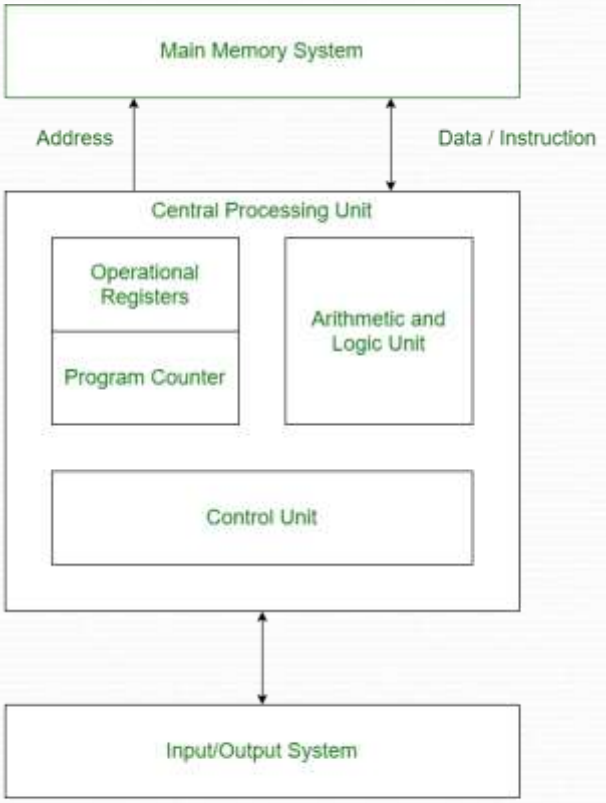
Type of Computer architecture

- Von Neumann
- Harvard Architecture

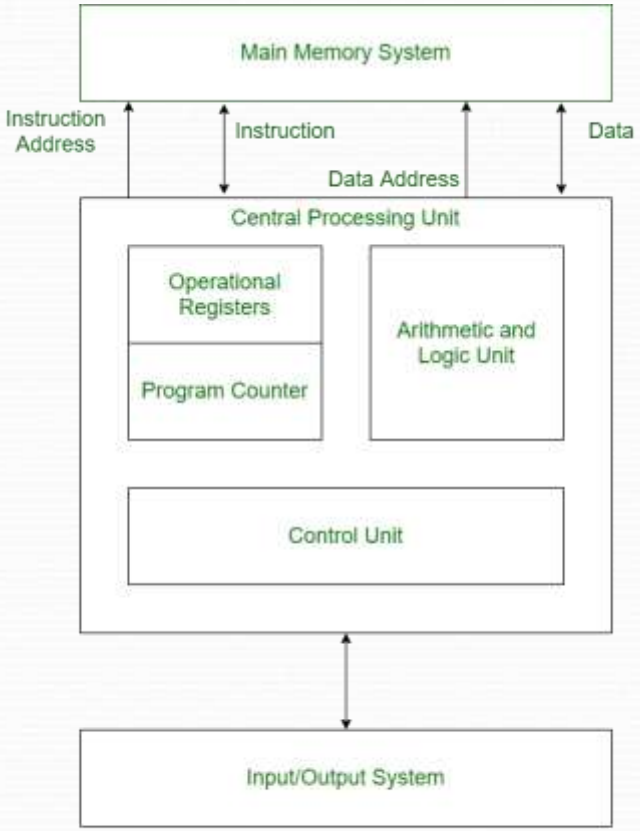
Difference between Von Neumann and Harvard Architecture

- **Von Neumann Architecture:**
  Von Neumann Architecture is a digital computer architecture whose design is based on the concept of stored program computers where program data and instruction data are stored in the same memory.
- **Harvard Architecture:**
  Harvard Architecture is the digital computer architecture whose design is based on the concept where there are separate storage and separate buses (signal path) for instruction and data.
- It was basically developed to overcome the bottleneck of Von Neumann Architecture.

Difference between Von Neumann and Harvard Architecture



Von Neumann Architecture



Harvard Architecture

Von Neumann Machine

- **Three key concepts:**
- Data and instructions are stored in a single set of read-write memory
- Contents of memory are addressable by memory address, without regard to the type of data contained
- Execution occurs in a sequential fashion, unless explicitly altered, from one instruction to the other

Microprocessor

- is a semiconductor device consisting of electronic logic circuits
- manufactured by using various fabrication schemes
- capable of performing computing functions
- capable of transporting data/information
- can be divided into 3 segments:
    - Arithmetic and Logic Unit
    - Register Unit
    - Control Unit

Computer System Components

- **Memory**

  Stores instructions and data

- **Input/Output**
  - Called peripherals
  - Used to input and output instructions and data

- **Arithmetic and Logic Unit**
  - – Performs arithmetic operations (addition, subtraction)
  - – Performs logical operations (AND, OR, XOR, SHIFT, ROTATE)

Computer System Components

- **Control Unit**
- – Coordinates the operation of the computer
- **System Interconnection and Interaction**
- Bus—A group of lines used to transfer bits between the microprocessor and other components of the computer system. Bus is used to communicate between parts of the computer. There is only one transmitter at a time and only the addressed device can respond.
- Types
  - » Address
  - » Data
  - » Control signals

CPU Components

Registers

- Hold data, instructions, or other items
- Various sizes
- Program counter and memory address registers must be of same size/width as address bus
- Registers which hold data must be of same size/width as memory words

CPU Components

Control Unit

- Generates control signals which are necessary for execution of an instruction.
- Connect registers to the bus.
- Controls the data flow between CPU and peripherals (including memory).
- Provides status, control & timing signals required for the operation of memory and I/O devices to the system.
- Acts as a brain of computer system
  All actions of the control unit are associated with the decoding and executions of instructions (fetch and execute cycles).

CPU Components

Arithmetic and Logic Unit

- Executes arithmetic and logical operations.
- Accumulator is a special 8-bit register associated with ALU.Register 'A' in 8085 is an accumulator.
  - Source of one of the operands of an arithmetic or logical operation.
  - serves as one input to ALU.
- Final result of an arithmetic or logical operation is placed in accumulator.

Arithmetic and Logic Unit

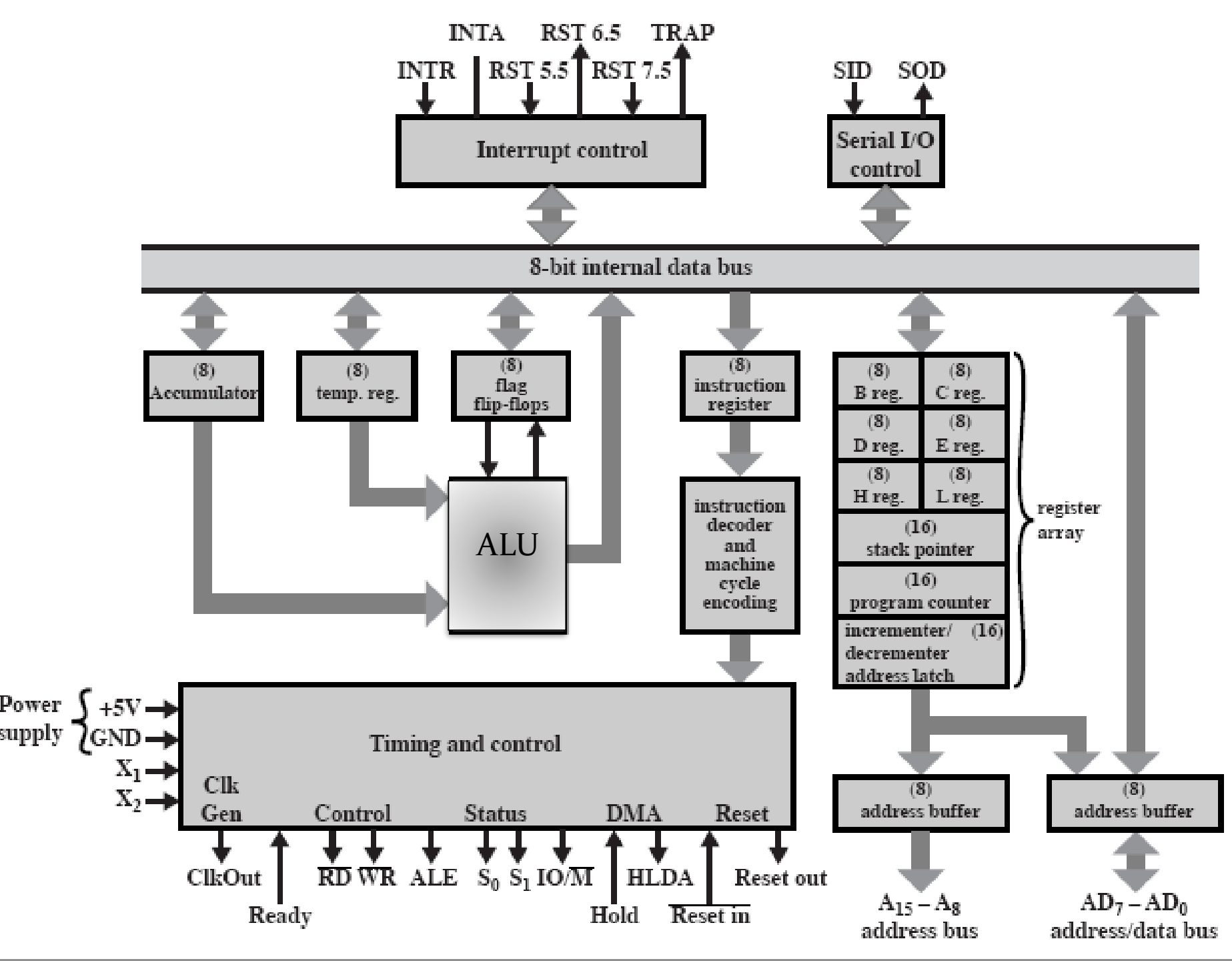
ALU performs the following arithmetic & logical operations:

- Addition
- Subtraction
- Logical AND
- Logical OR
- Logical EXCLUSIVE OR
- Complement(logical NOT)
- Increment (add 1)
- Decrement (subtract 1)
- Left shift, Rotate Left, Rotate right
- Clear etc.

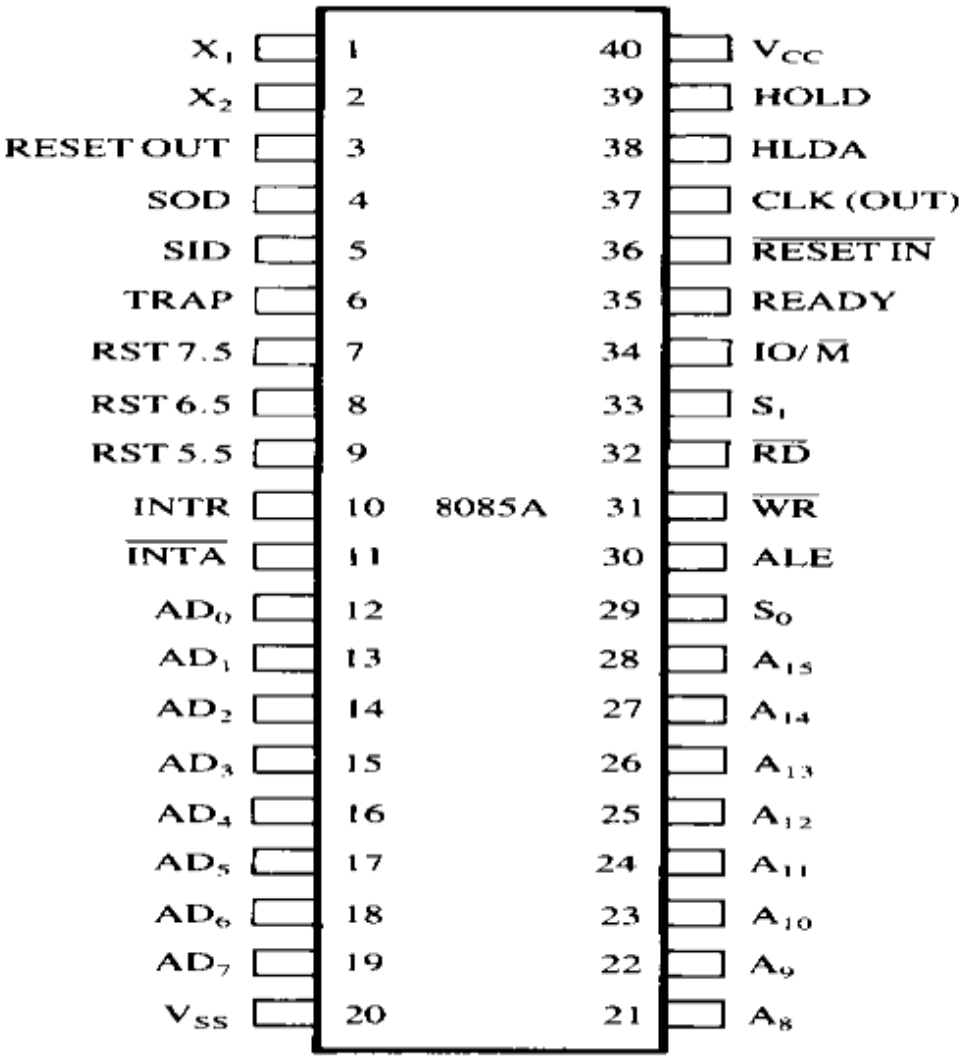
Status Flags

- Intel 8085 microprocessor contains five flip-flops to serve as status flags. The flip-flops are set or reset according to the conditions which arise due to an arithmetic & logical operation

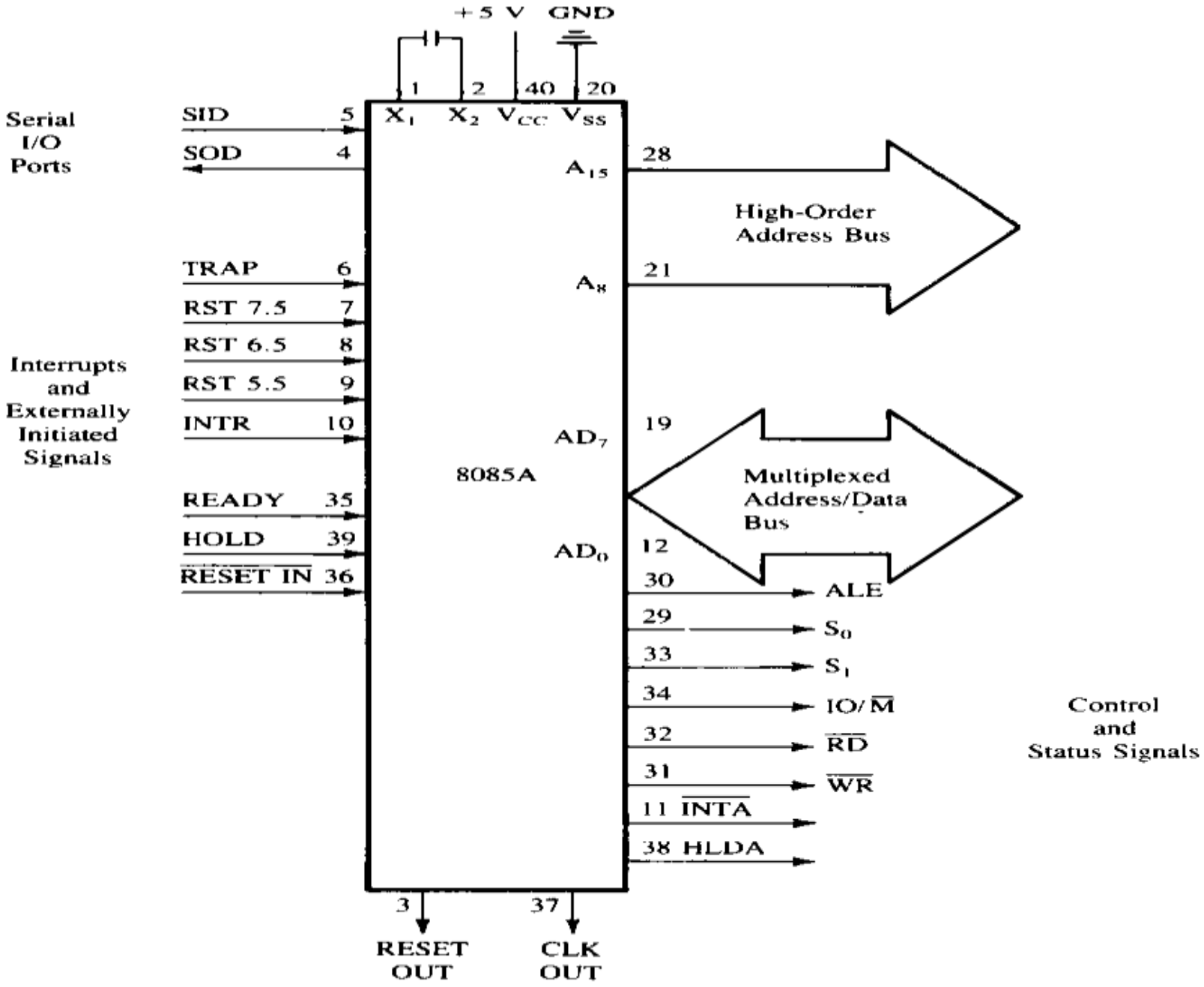
Intel 8085 Architecture


INTA
RST 6.5
TRAP
INTR
RST 5.5
RST 7.5
Interrupt control
SID
SOD
Serial I/O control
8-bit internal data bus
(8) Accumulator
(8) temp. reg.
(8) flag flip-flops
ALU
(8) instruction register
instruction decoder and machine cycle encoding
(8) B reg.
(8) C reg.
(8) D reg.
(8) E reg.
(8) H reg.
(8) L reg.
(16) stack pointer
(16) program counter
incrementer/ decrementer address latch (16)
register array
Power supply
+5V
GND
X_1
X_2
Timing and control
Clk Gen
Control
Status
DMA
Reset
ClkOut
Ready
RD
WR
ALE
S_0
S_1
IO/M
Hold
HLDA
Reset in
Reset out
(8) address buffer
(8) address buffer
$A_{15} - A_8$ address bus
$AD_7 - AD_0$ address/data bus

PIN DIAGRAM 0F 8085



8085 Pinout


+5 V
GND
1
2
40
20
X1
X2
VCC
VSS
8085A
Serial I/O Ports
SID
5
SOD
4
Interrupts and Externally Initiated Signals
TRAP
6
RST 7.5
7
RST 6.5
8
RST 5.5
9
INTR
10
READY
35
HOLD
39
RESET IN
36
A15
28
A8
21
High-Order Address Bus
AD7
19
AD0
12
Multiplexed Address/Data Bus
ALE
30
S0
29
S1
33
IO/M
34
RD
32
WR
31
INTA
11
HLDA
38
Control and Status Signals
RESET OUT
3
CLK OUT
37